

REMARKS

By this amendment, claims 1, 2, 5, 6, 8-10, 24, and 25 have been amended and claims 1-18 and 20-28 are now pending in the present application. Support for the claim amendments can be found in the application and claims as filed, in particular from page 15, line 14 to page 16, line 21 of the application as filed. The amendment to the specification corrects a minor typographical error that is unrelated to the patentability of the claims. Accordingly, favorable reconsideration of the pending claims is respectfully requested.

1. Non-Rejected Claims

Applicants note that claims 23 and 28 are not currently objected to nor rejected. Accordingly, the prompt allowance of these claims is respectfully requested.

2. Rejections under 35 U.S.C. § 112

Claim 5 has been rejected under 35 U.S.C. § 112, second paragraph, for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. More particularly, the Office Action states that it is unclear as to which claim claim 5 depends from because there is no antecedent basis for the heating step of the first dielectric layer. Applicants respectfully traverse.

As amended in the Amendment and Response filed April 17, 2003, claim 5 depends from claim 2, not claim 24. In addition, claim 5 has now been amended to more explicitly provide the requested antecedent basis: “wherein the step of heating said dielectric upper layer.” The prompt removal of this rejection is therefore respectfully requested.

Claims 15, 17, 18, and 20-22 have been rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. More particularly, the Office Action indicates that “the step of heating the first dielectric layer to a first temperature and thereafter heating the first dielectric layer to a second temperature” lacks support in the original disclosure. Applicants respectfully traverse.

For support for the relevant limitations in claims 15, 17, 18, and 20-22, Applicants direct the Examiner to the Application as filed at page 16, lines 11-20.

As an alternative embodiment and in connection with the reduction of the amount of ammonia in the mixture, processing conditions may be altered from conditions that are less likely to cause formation to oxide husk 20 to conditions that are more likely. For example, processing temperatures sufficient to form passivation layer 32 may be initiated with an ammonia-rich mixture under conditions not likely to cause formation of oxide husk 20. As the amount of ammonia in the mixture is reduced, processing temperatures may be increased proportionally under conditions that are more likely to cause formation of oxide husk 20 than under conditions previously established when the amount of ammonia in the mixture is greater. The initial formation of some of passivation layer 32, however, resists the formation of oxide husk 20.

(emphasis added). As evidenced by this passage, support is provided for embodiments of the invention that heat a dielectric layer to a first temperature (“processing temperatures sufficient to form passivation layer 32”) and thereafter heat the first dielectric layer to a second temperature (“processing temperatures may be increased proportionally under conditions that are more likely to cause formation of oxide husk 20”).

Accordingly, the prompt removal of this rejection is therefore respectfully requested.

3. Rejections Under the Judicially Created Doctrine of Double Patenting

Claims 1-14, 16, and 24-27 have been rejected under the judicially created doctrine of obviousness-type double patenting over claims 1-46 of U.S. Patent No. 6,150,257 to Yin et al. for the reasons set forth on page 2 of the Office Action.

This rejection will be addressed when allowable subject matter has been indicated by the Examiner.

2. Rejections Under 35 U.S.C. §103

Claims 1, 2, 5-14, and 24-27 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,529,954 to Iijima et al. (hereinafter “*Iijima*”) taken with U.S. Patent No. 5,633,200 to Hu (hereinafter “*Hu*”) for the reasons set forth on pages 4-6 of the Office Action. Applicants respectfully traverse.

Present claims 1, 6, and 10 now recite a passivation layer thickness of less than about 50 Å. The reason for these relatively thin layers comes directly from the use of the passivation layers to passivate, or “blind off,” the surface of a tungsten interconnect. As noted in the specification:

The chemical compound is provided in an amount sufficient to substantially chemically cover upper surface 16 of interconnect 12 in order to chemically protect approximately the first 1-1,000 atomic lattice layers thereof.

* * *

The chemical compound may be, by way of non-limiting example, the nitrogen-containing chemical compound such as ammonia that has been adsorbed onto upper surface 16 of interconnect 12 sufficiently to **substantially chemically cover or "blind off" substantially any chemically reactive**

portion of upper surface 16 of interconnect 12 during formation of ILD layer 18.

Specification at page 10, lines 4-14 (emphasis added). These thin layer thicknesses are not conventional in the art because they would not suit any heretofore disclosed use for the passivation layers. While it is true that forming a nitride film on a tungsten layer has been performed before, it was previously done for different reasons and therefore resulted in much thicker layers.

For example, *Hu* discloses physical vapor deposition processes to form large grain tungsten nitride films for use as a diffusion barrier. Col. 8, lines 19-23. Thus, the only disclosed thickness for the tungsten nitride film is 100 nm (1,000 Å). Col. 9, lines 47-50. Also in contrast to the present thin passivation layers, *Iijima* performs an anneal to form discrete TiO_2 , TiN , and MgN_x layers that are sufficiently thick to be used as an etch stop (Col. 6, lines 40-41) and prevent silver agglomeration (Col. 6, lines 26-31). In fact, the minimum thickness of these layers is 150 Å (Col. 11, lines 14-16), which is several times the maximum thickness disclosed in the application. Assuming, *arguendo*, that these prior art references teach methods that might possibly create layers as thin as those presently claimed, there is simply no teaching in the prior art or motivation for one skilled in the art to do so. Further, the presently claimed methods would not be attained by any routine optimization because, as previously noted, prior art methods were focused on different goals that required thicker layers.

Nevertheless, the Office states, “It would have been conventional and would have been within the purview of one skilled in the art to have selected appropriate and suitable layer thicknesses.” Office Action, page 6. Thus, after briefly identifying various other teachings of

Iijima and Hu, the Examiner merely makes a broad conclusory statement, unsupported by any factual basis or support, to the effect that it would have been obvious to form a passivation layer of thickness several times thinner than any that are taught or suggested in the art.

Applicants therefore submit that it is improper for the Examiner, with the benefit of hindsight and armed with Applicants' invention as a road map, to simply state that a claimed limitation is obvious without providing any specific teaching of the claimed limitation or suggestion in the prior art to make the proposed modification. Applicants have earnestly studied the cited references and have been unable to locate any teaching, suggestion or motivation for forming a thin passivation layer as presently claimed. Applicants therefore respectfully request the Examiner to point out, by column and line numbers, any teaching or suggestion expressly set forth in the cited references that provides any suggestion to modify the references in the manner suggested by the Examiner.

Next, claims 6 and 24 have been amended to recite some form of the limitation: "the step of forming the passivation layer comprises heating said first dielectric layer to a first temperature and thereafter heating said first dielectric layer to a second temperature, wherein the first temperature is less favorable to the formation of an oxide husk on said upper surface than the second temperature." Specification at page 16, lines 11-20.

None of the cited references teach or suggest any such limitation. Accordingly, the prompt allowance of these claims is respectfully requested.

Additionally, present claims 10 and 25 now recite some form of the limitation: "the step of forming the passivation layer further comprises: exposing the upper surface to a plasma having a first concentration of a chemical composition used to form the passivation layer; and

incrementally reducing the concentration of the chemical composition until it is completely removed from the presence of the upper surface.” Support for these amendments can be found in the application as filed from page 15, line 17 to page 16, line 20.

Because none of the cited references teach or suggest these features of the invention, the prompt allowance of these claims is also respectfully requested.

Regarding claim 13, *Iijima* and *Hu* do not teach or suggest multiple passivation layers, let alone a first passivation layer comprising a tungsten nitride film and a second passivation layer comprising ammonia and its derivatives that is adsorbed onto the first passivation layer.

Therefore, the combination of *Iijima* with *Hu* fails to teach or suggest the limitations of claims 1, 2, 5-14, and 24-27, and the withdrawal of these rejections is respectfully requested.

Claims 3 and 4 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over *Iijima* taken with *Hu* and further in view of U.S. Patent No. 5,592,024 to Aoyama et al. (hereinafter “*Aoyama*”) for the reasons set forth on pages 6-7 of the Office Action. Applicants respectfully traverse.

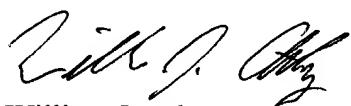
Claims 3 and 4 depend from claim 1 and thus include the limitations thereof. Accordingly, claims 3 and 4 are patentable over the cited prior art for at least the reasons presented hereinabove with respect to claim 1. Applicants therefore respectfully request that the rejection of claims 1-25 under 35 U.S.C. § 103(a) be withdrawn.

CONCLUSION

In view of the foregoing, Applicants respectfully request favorable reconsideration and allowance of the present claims. In the event the Examiner finds any remaining impediment to the prompt allowance of this application that could be clarified by a telephone interview, the Examiner is respectfully requested to contact the undersigned attorney.

Dated this 3rd day of September, 2003.

Respectfully submitted,



William J. Athay
Attorney for Applicants
Registration No. 44,515
Customer No. 022901

WORKMAN NYDEGGER
Telephone: (801) 533-9800
Fax: (801) 328-1707

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